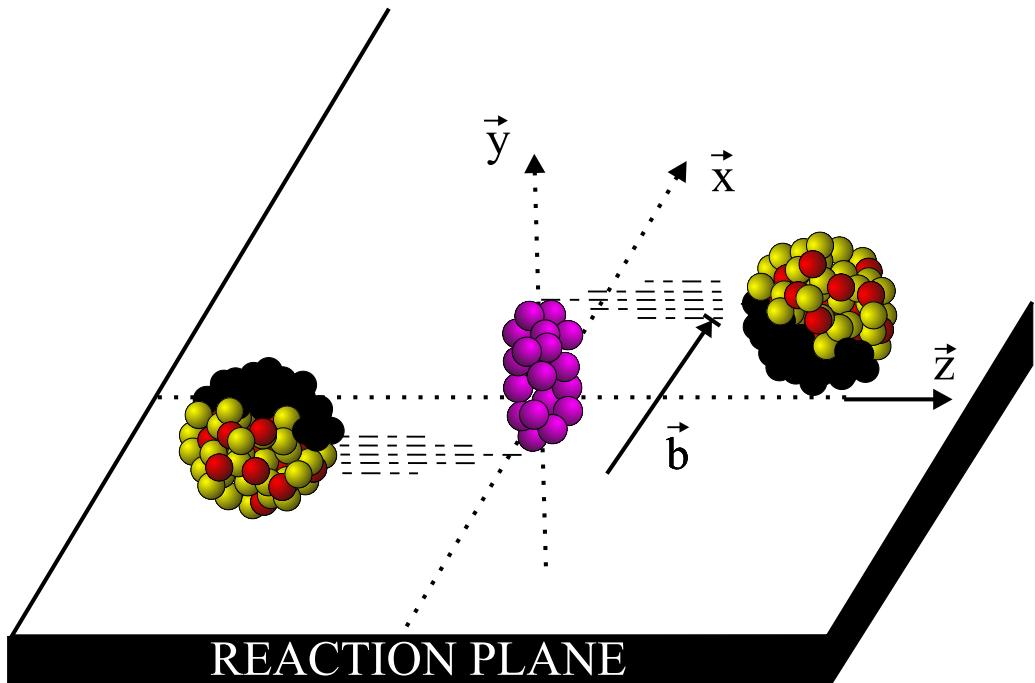


Event anisotropy at RHIC



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 - v_1, v_2 and r_1, r_2
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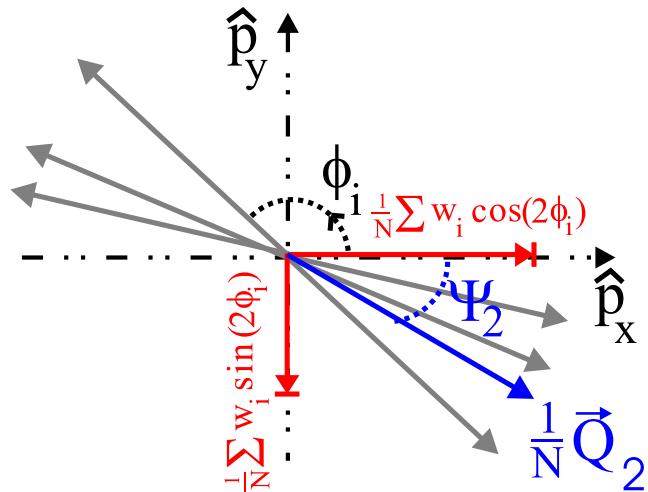
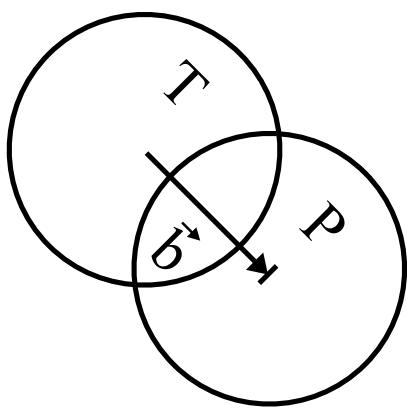
References

- [1] W. Reisdorf and H.G. Ritter, Annu. Rev. Nucl. Part. Sci. **47**, 663 (1997).
- [2] P. Danielewicz and G. Odyniec, Phys. Lett. **157B**, 146 (1985).
- [3] J.-Y. Ollitrault, Phys. Rev. D **46**, 229 (1992); Phys. Rev. D **48** 1132 (1993).
- [4] S. Voloshin and Y. Zhang, Z. Phys. C **70**, 665 (1996).
- [5] J.-Y. Ollitrault, preprint nucl-ex/9711003, submitted to Phys. Rev. C.
- [6] NA49 Collaboration, H. Appelshäuser *et al.*, Phys. Rev. Letters **80**, 4136 (1998); A.M. Poskanzer *et al.*, Nucl. Phys. **A638**, 463c (1998).
- [7] A.M. Poskanzer and S.A. Voloshin, Phys. Rev. C **58**, 1671 (1998).
- [8] S.A. Voloshin and W.E. Cleland, Phys. Rev. C **53**, 896 (1996); Phys. Rev. C **54**, 3212 (1996).
- [9] S.A. Voloshin, Phys. Rev. C **55**, R1630 (1997).
- [10] S.A. Voloshin, R. Lednicky, S. Panitkin, and N. Xu, Phys. Rev. Lett. **79**, 4766 (1997).
- [11] H. Sorge, Phys. Rev. Lett. **78**, 2309 (1996); Phys. Letters B **402**, 251 (1997); in *Advances in Nuclear Dynamics 3*, edited by Bauer and Mignerey, (Plenum Press, New York 1997), p. 1.
- [12] M. Gyulassy and M. Plümer, Phys. Lett. B **243**, 432 (1990); M. Thoma and M. Gyulassy, Nucl. Phys. B **351**, 491 (1991); M. Plümer, M. Gyulassy and X.-N. Wang, Nucl. Phys. A **590**, 511c (1995).
- [13] M. Gyulassy and X.-N. Wang, Comp. Phys. Comm. **83**, 307 (1994).
- [14] H. Liu, S. Panitkin, and N. Xu, nucl-th/9807021.
- [15] H. Heiselberg and A.-M. Levy, nucl-th/9812034.
- [16] B.K. Nandi, G.C. Mishra, B. Mohanty and D.P. Mahapatra, nucl-ex/9812004
- [17] H. Sorge, nucl-th/9812057

Motivation and definitions

- Event plane reconstruction:

$$E \frac{d^3 N}{d^3 p} = \frac{1}{2\pi} \frac{d^2 N}{p_t dp_t dy} \left(1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \Psi_r)] \right)$$



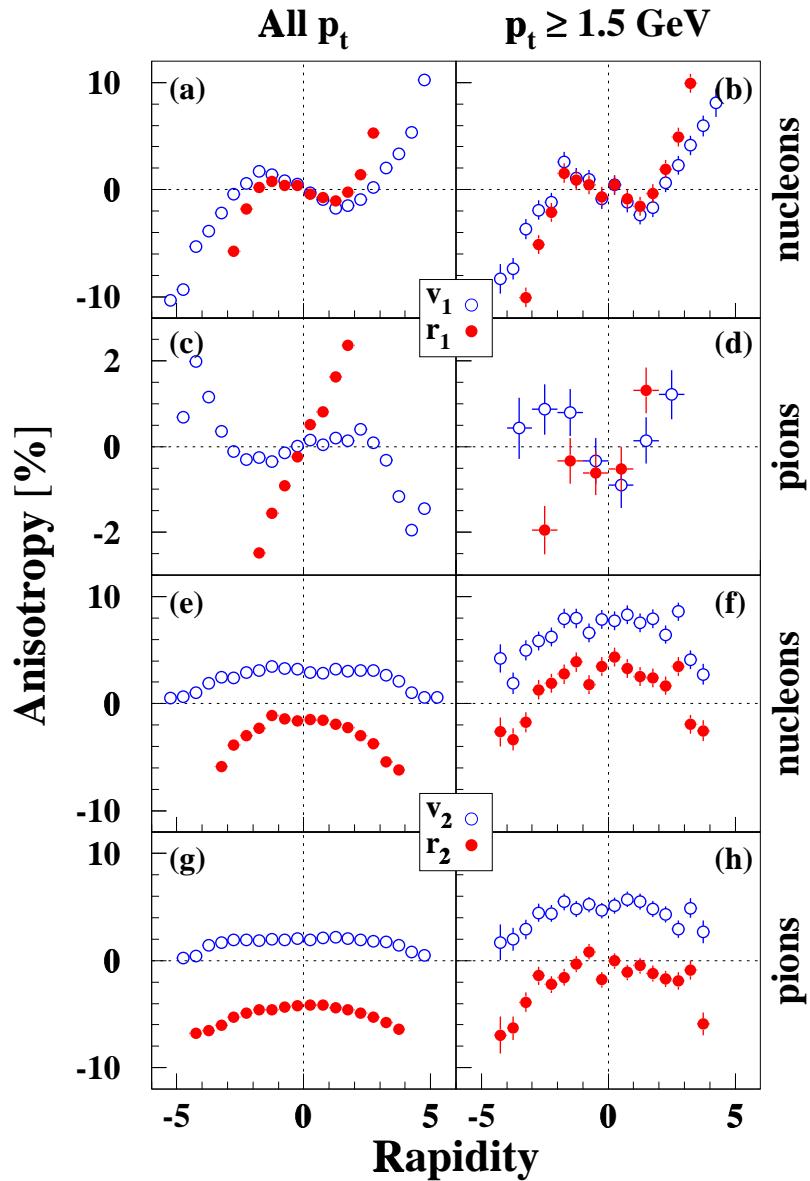
$$Q_n \cos(n\Psi_n) = \sum_i^N w_i \cos(n\phi_i), \quad Q_n \sin(n\Psi_n) = \sum_i^N w_i \sin(n\phi_i)$$

$$\Psi_n = \frac{1}{n} \left(\tan^{-1} \frac{\sum_i^N w_i \sin(n\phi_i)}{\sum_i^N w_i \cos(n\phi_i)} \right)$$

- Observables with respect to the reaction plane:

- Anisotropic flow \Rightarrow thermalization?, QGP?, jet quenching?, DCC?
- HBT \Rightarrow expanding source?

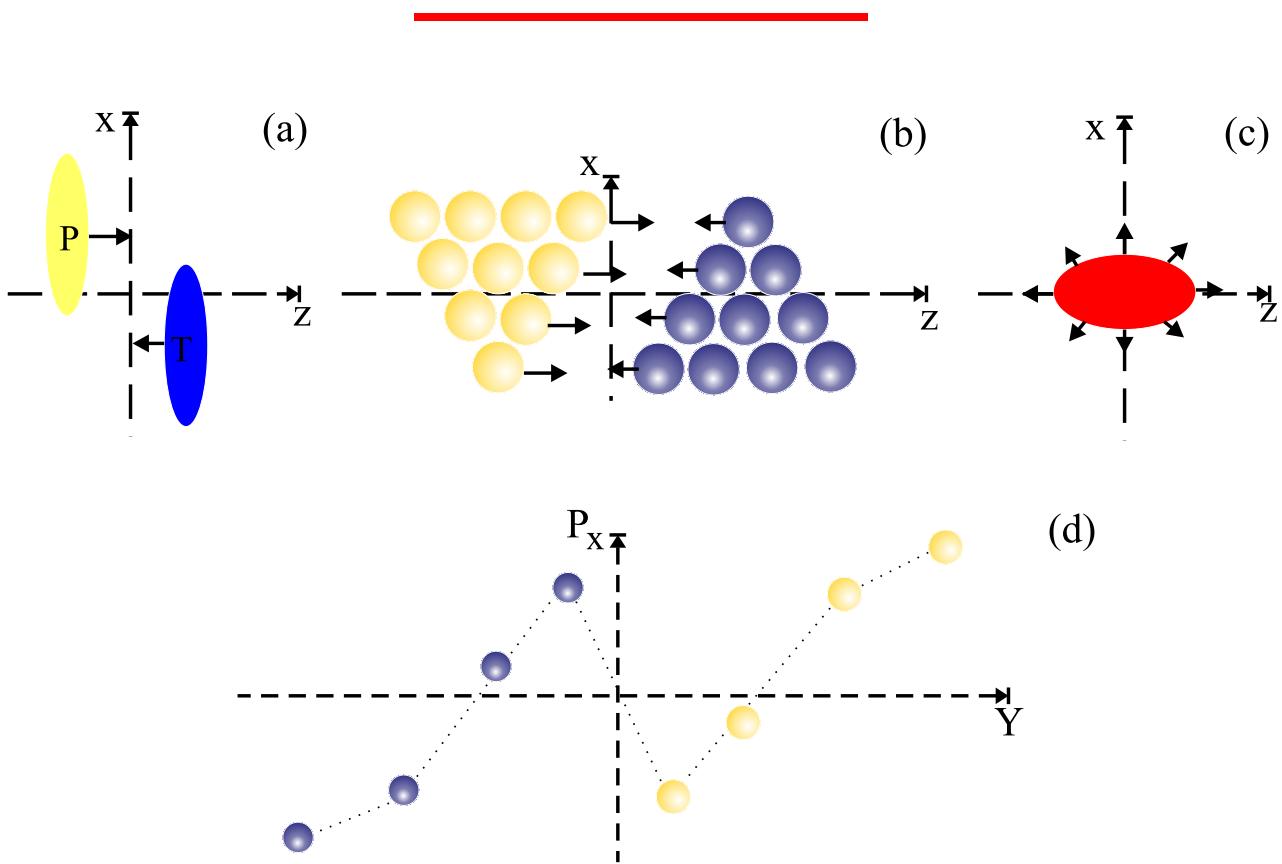
RQMD (Au +Au $\sqrt{s} = 200 \text{AGeV}$ $5 \leq b \leq 10$)



$$v_n = \langle \cos[n(\phi - \Psi_r)] \rangle$$

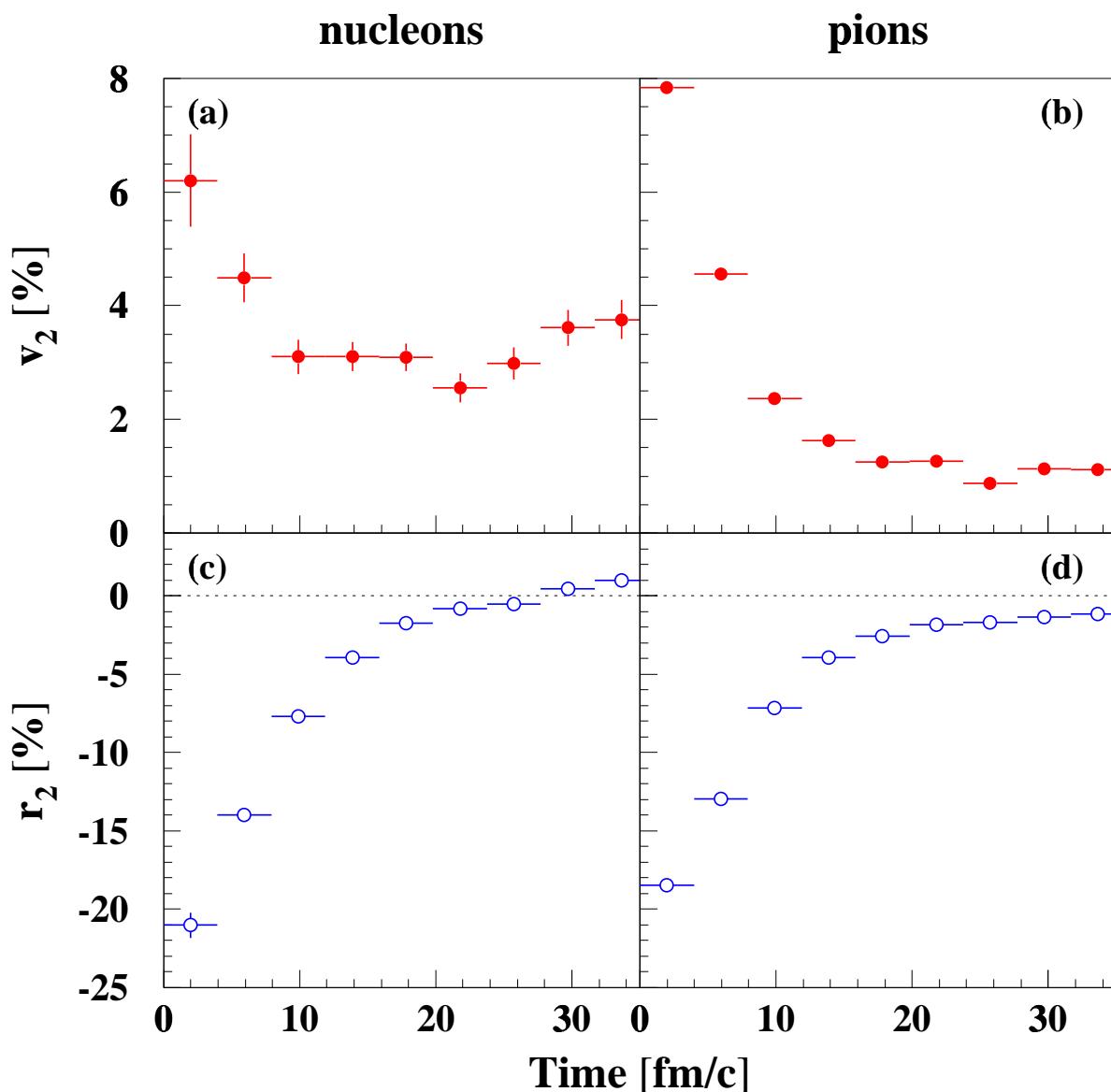
$$r_n = \langle \cos[n(\text{atan}(\frac{y}{x}) - \Psi_r)] \rangle$$

v_1 , reversal of sign

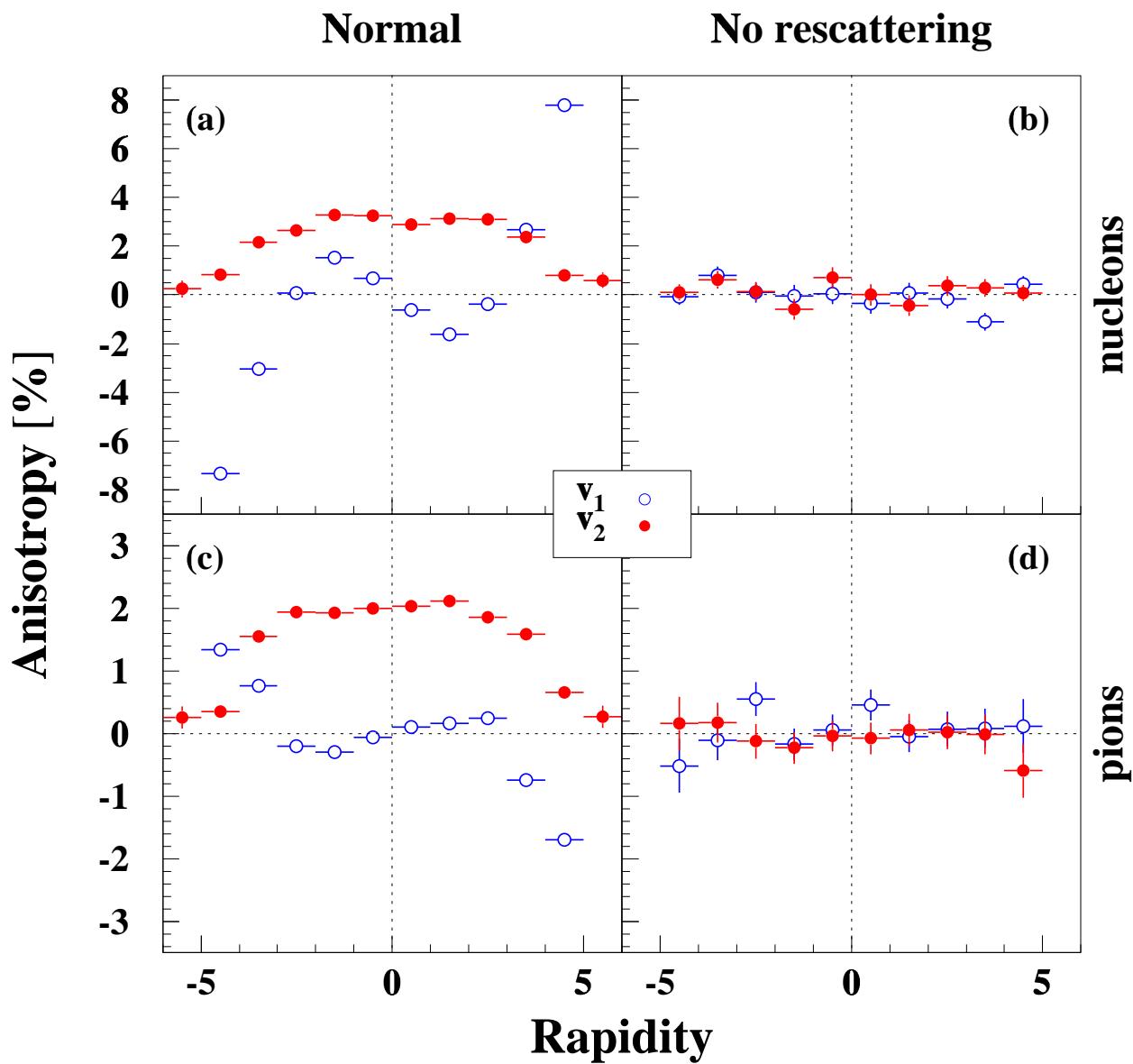




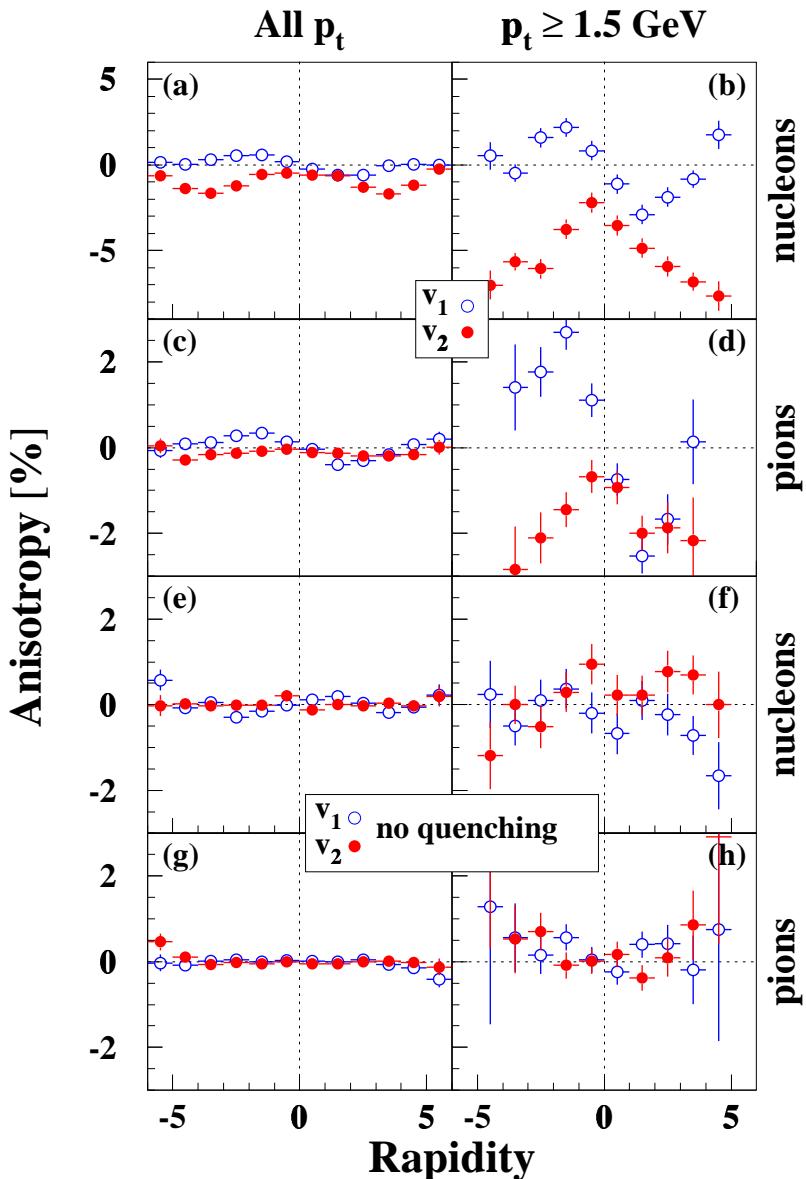
RQMD (Au +Au $\sqrt{s} = 200\text{AGeV}$ $5 \leq b \leq 10$)



RQMD (Au + Au $\sqrt{s} = 200 A \text{GeV}$ $5 \leq b \leq 10$)



HIJING (Au + Au $\sqrt{s} = 200A\text{GeV}$ $5 \leq b \leq 10$)



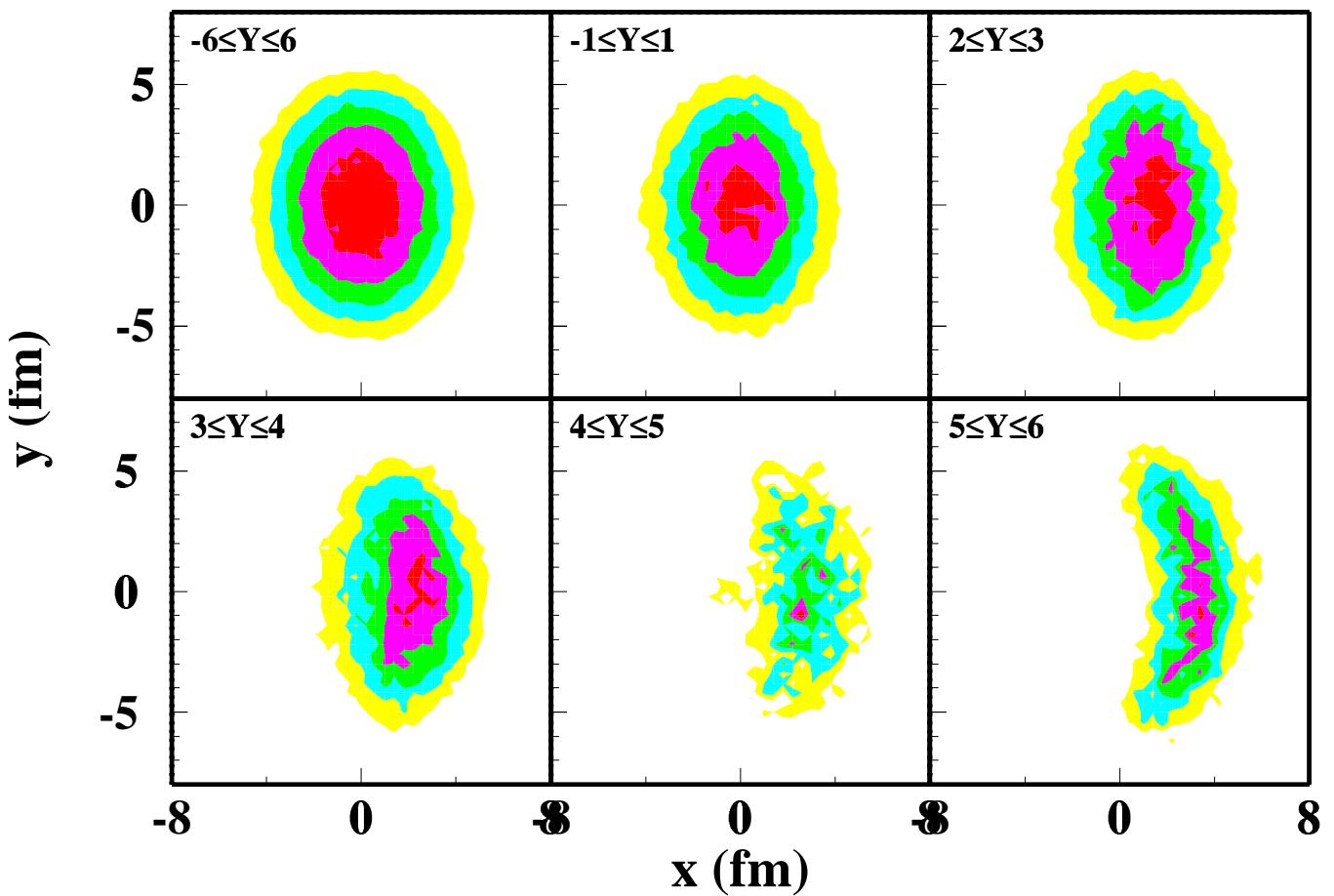
$$v_n = \langle \cos[n(\phi - \Psi_r)] \rangle$$

$$r_n = \langle \cos[n(\arctan(\frac{y}{x}) - \Psi_r)] \rangle$$



HIJING (Au +Au $\sqrt{s} = 200\text{AGeV}$ $5 \leq b \leq 10$)

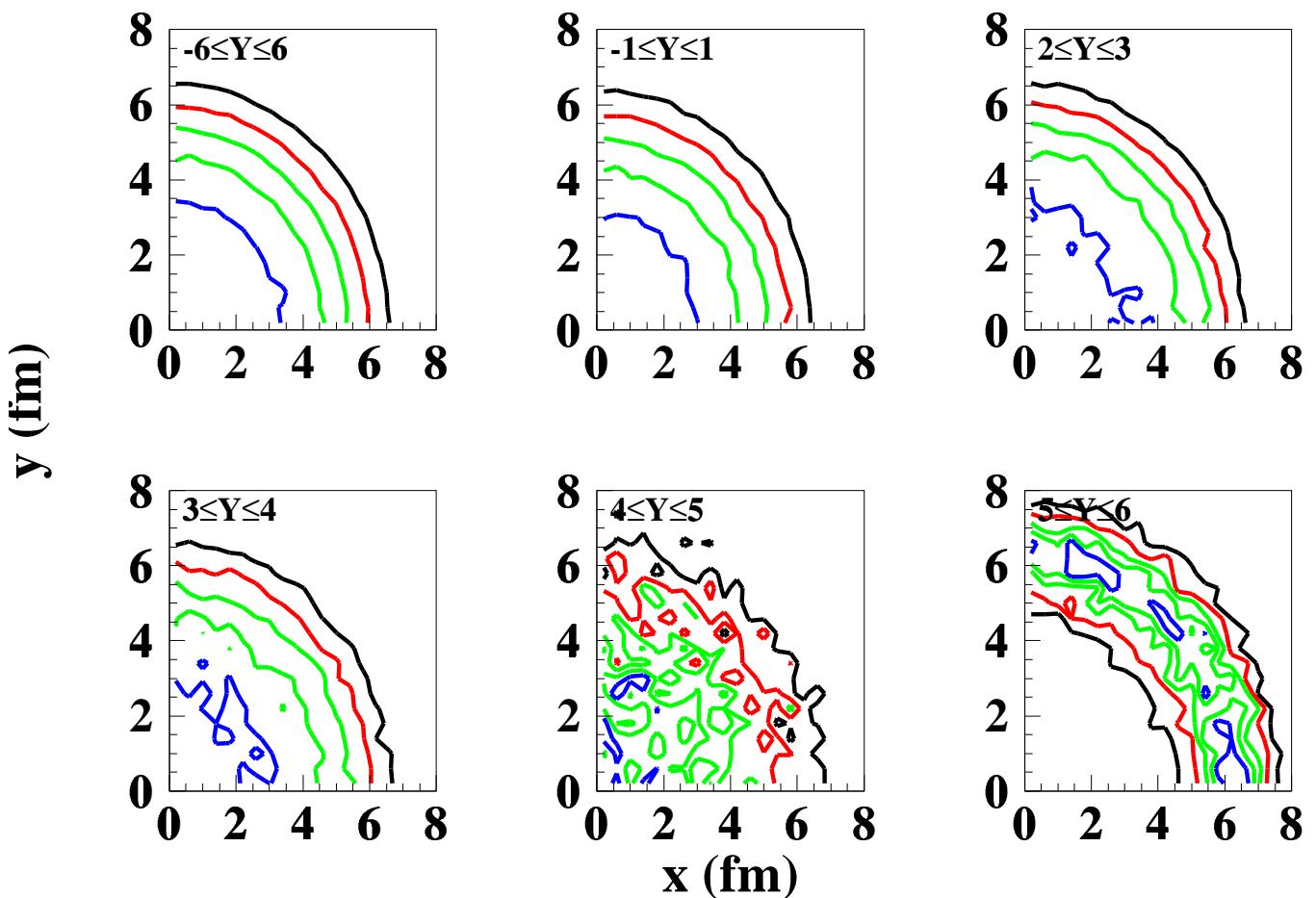
Hijing wounded nucleons



HIJING (Au +Au $\sqrt{s} = 200 A \text{GeV}$ $b = 0$)



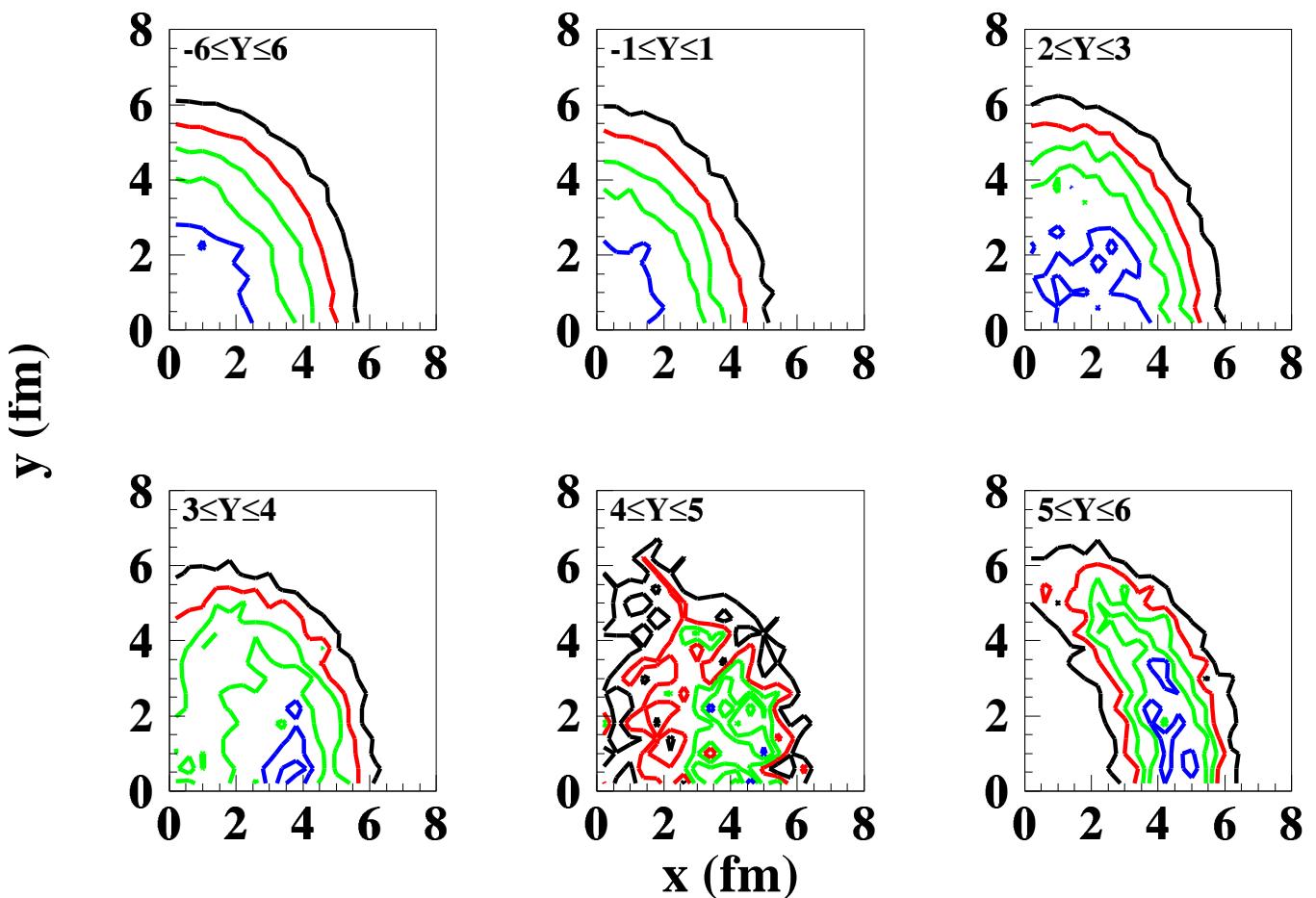
Hijing wounded nucleons $b = 0$ fm



HIJING (Au +Au $\sqrt{s} = 200 A \text{GeV}$ $b = 5$)



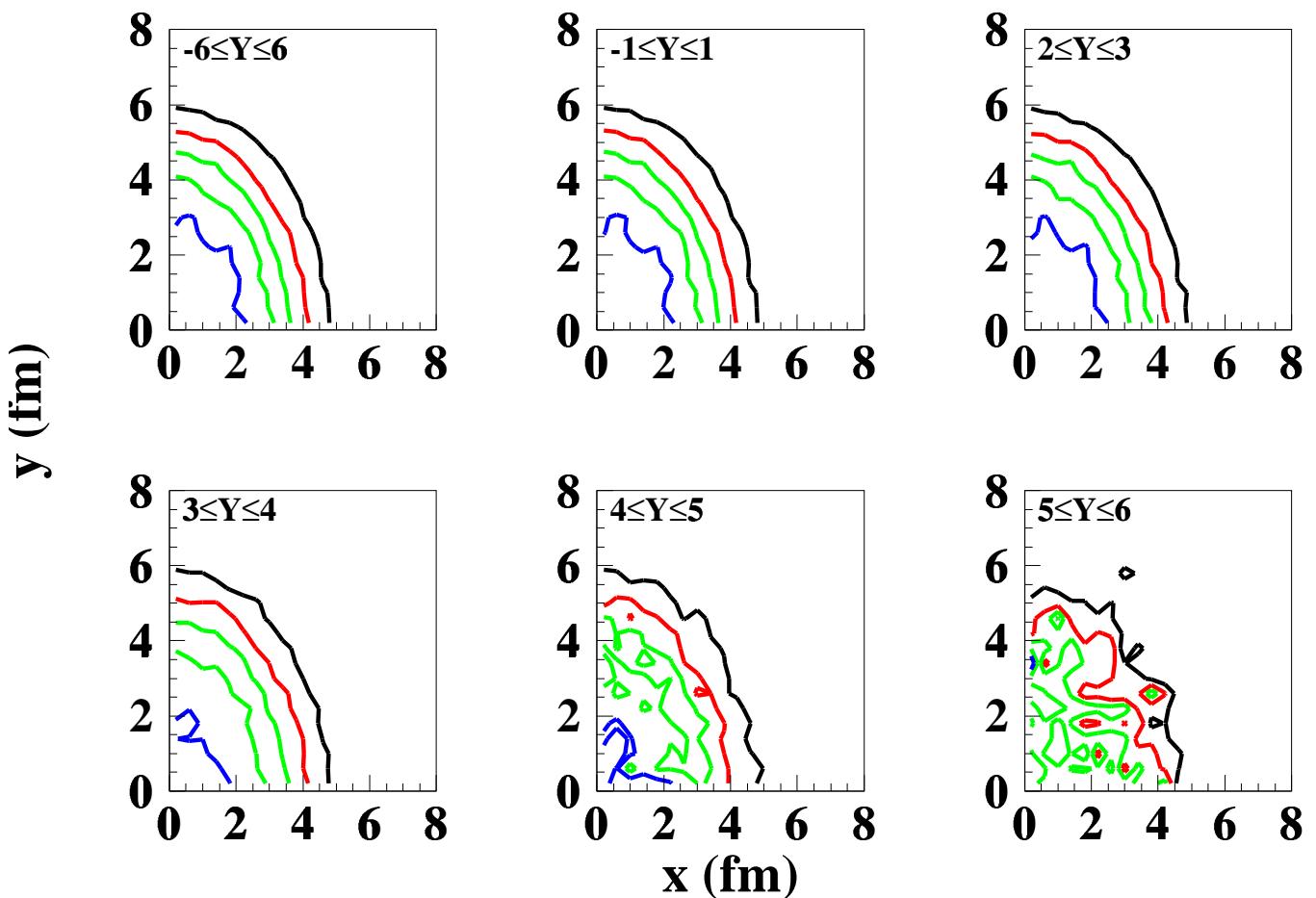
Hijing wounded nucleons $b = 5 \text{ fm}$



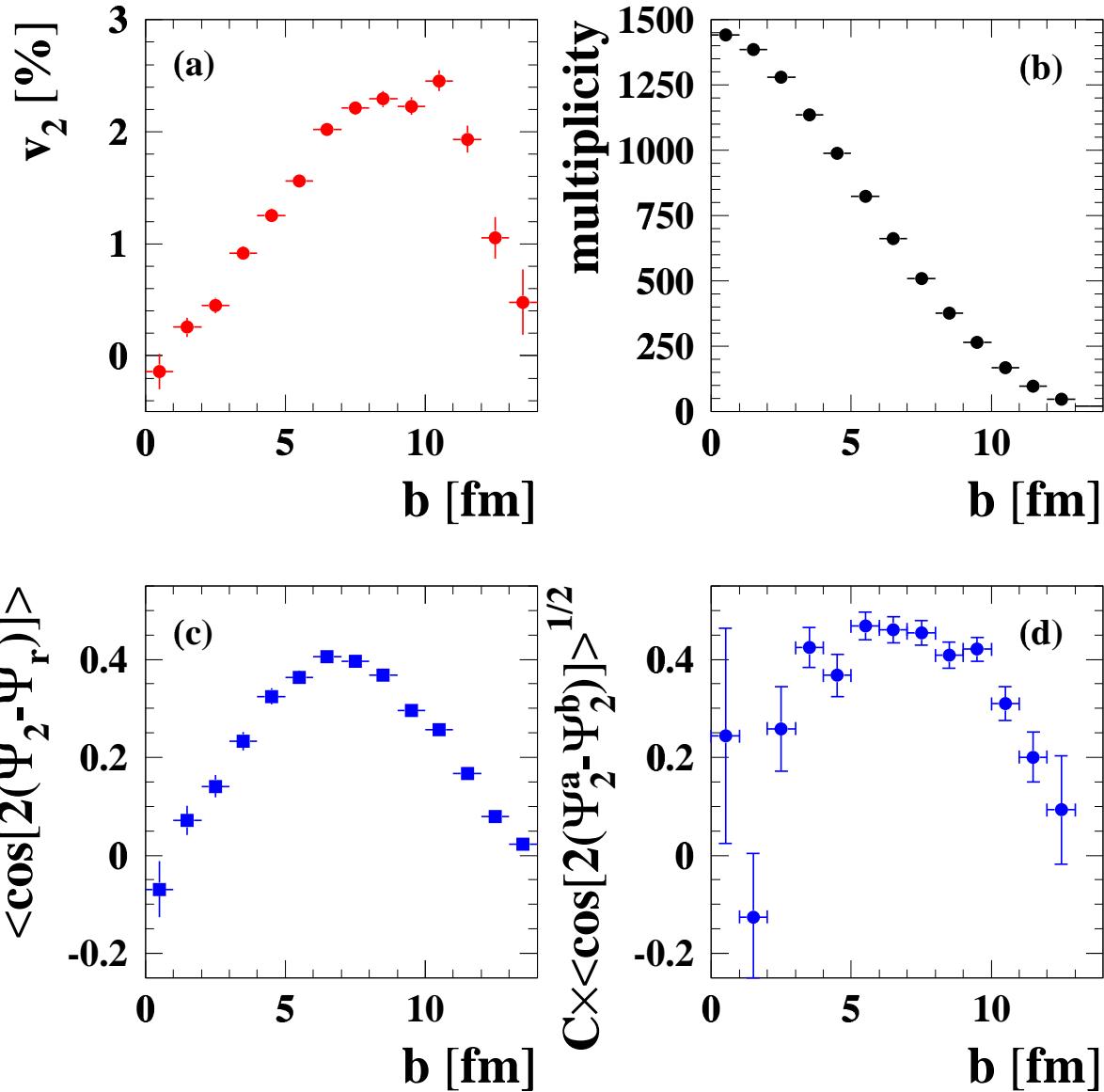
HIJING (Au +Au $\sqrt{s} = 200 A \text{GeV}$ $b = 5$)



Hijing parton jets $b = 5 \text{ fm}$



Event plane resolution (v_2 , $\pi^+ + \pi^-$, TPC)

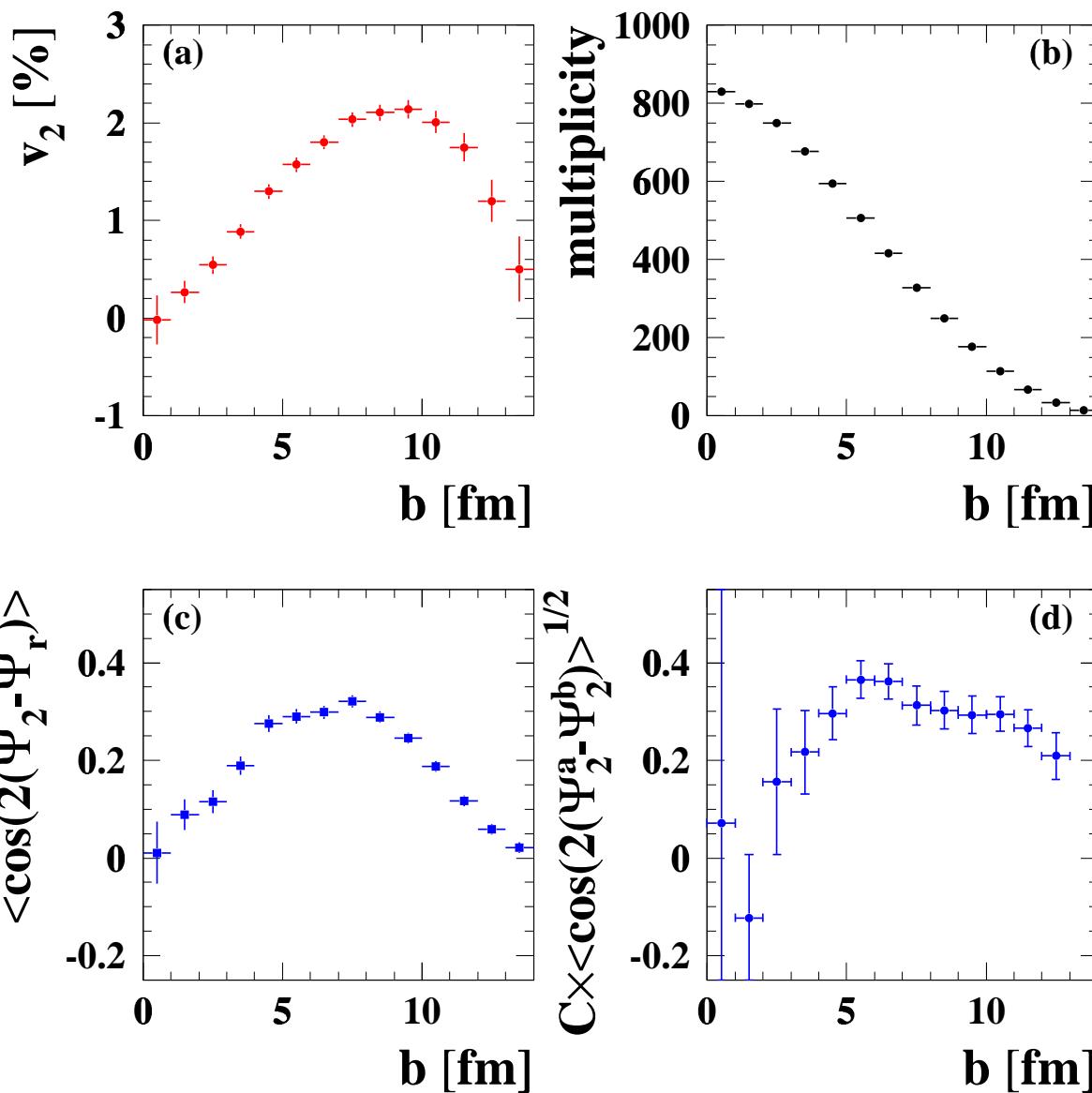


$$v_n = \frac{v_n^{\text{obs}}}{\langle \cos[n(\Psi_n - \Psi_r)] \rangle}$$

$$\langle \cos[n(\Psi_n^a - \Psi_r)] \rangle = \sqrt{\langle \cos[n(\Psi_n^a - \Psi_n^b)] \rangle}$$

v_2 , FTPC charged pions + protons

Red horizontal bar indicates centrality range 20-40%.

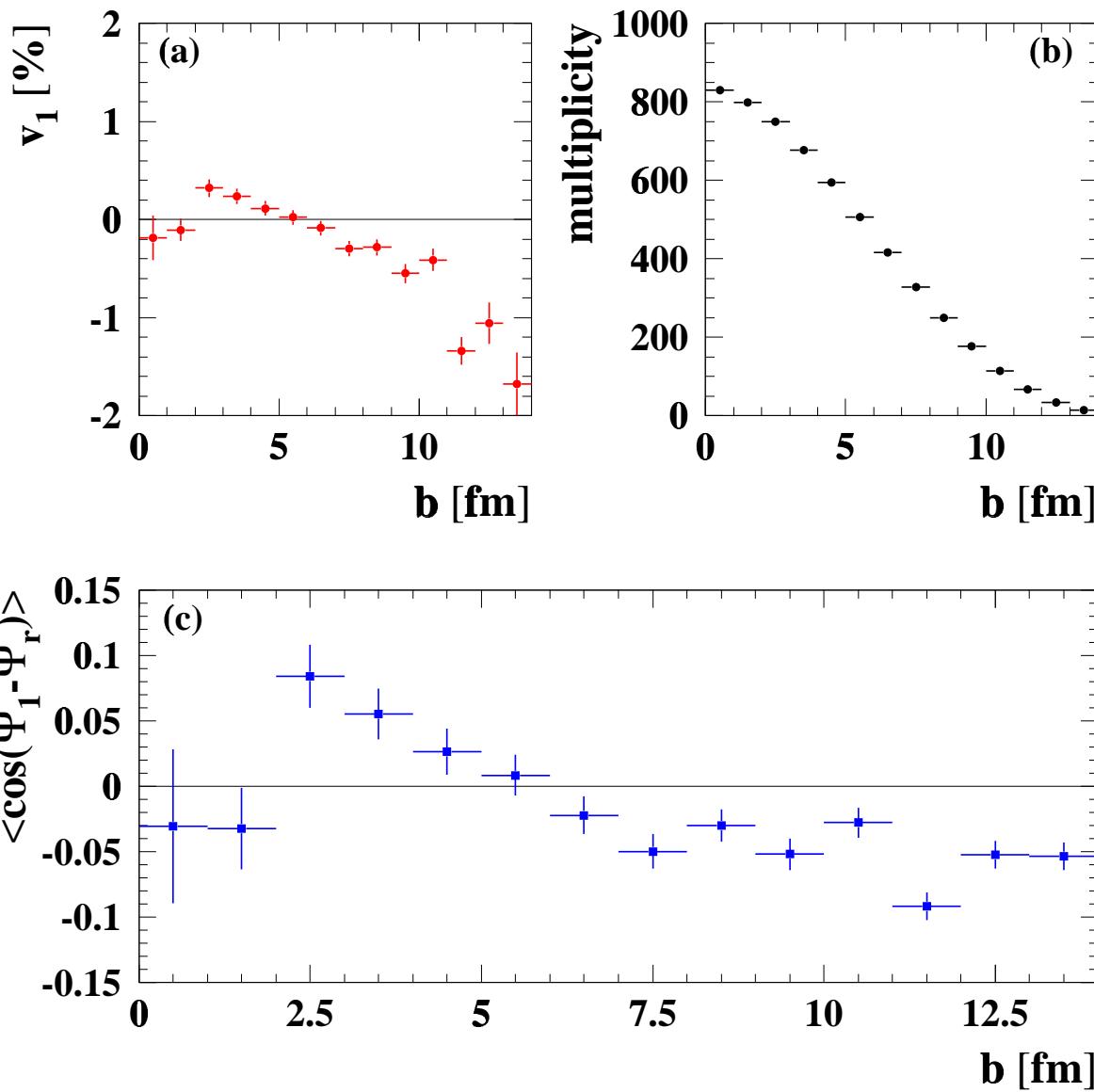


$$v_n = \frac{v_n^{\text{obs}}}{\langle \cos[n(\Psi_n - \Psi_r)] \rangle}$$

$$\langle \cos[n(\Psi_n^a - \Psi_r)] \rangle = \sqrt{\langle \cos[n(\Psi_n^a - \Psi_n^b)] \rangle}$$

v_1 , FTPC charged pions + protons

Red horizontal bar indicates centrality range.



$$v_n = \frac{v_n^{\text{obs}}}{\langle \cos[n(\Psi_n - \Psi_r)] \rangle}$$

$$\langle \cos[n(\Psi_n^a - \Psi_r)] \rangle = \sqrt{\langle \cos[n(\Psi_n^a - \Psi_n^b)] \rangle}$$



Summary / Conclusions

- Determining the event plane gives us v_n .
 - HBT with respect to the event plane gives us information on r_n .
 - Both these observables will be essential for understanding the physics of RHIC.
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-
-
- v_2 probably easily accessible in STAR TPC (40 000 RQMD events).
≤ 12 hours beam time at 1 Hz, real “day one” physics
 - v_1 probably not easily accessible in STAR FTPC.